

REMARKS

In the Final Office Action mailed January 15, 2004, claims 1-16 were rejected under 35 USC §103 as unpatentable over Mayer et al. (USP 6,315,883) in view of Shue et al. (USP 6,083,835).

Applicants respectfully traverse the rejections and amend independent claim 1 and dependent claims 2, 3, and 10-14 to further clarify features that are not taught or suggested by the references. The amendment also places the rejected claims in better form for consideration on appeal. Accordingly, Applicants respectfully request entry of this amendment.

§103 Rejections

Claims 1-16 were rejected under §103 as obvious in view of Mayer et al. and Shue et al.

Under the Graham test, three factors must be evaluated: the scope and content of the prior art; the differences between the prior art and the claimed invention; and the level or ordinary skill in the art. (MPEP 706 and 2141 et seq.).

Independent claim 1, as amended recites:

...

applying a metallic conducting material layer having substantially a same conductivity characteristic as the non-planar conductive surface layer onto a top surface of the conductive surface layer of the workpiece using one of a spin-on, spray, doctor blading or other application technique that does not involve electroplating so that a top surface of the conducting material layer is planar, thus forming a planarized multi-layer structure that includes the non-planar conductive surface layer and the metallic conducting material layer; and

electropolishing the planarized multi-layer structure to remove in a planar manner at least portions of the non-planar conductive layer and other portions of the metallic conducting material layer, wherein the electropolishing in the planar manner is assisted by using conducting material in the metallic conducting material layer that electropolishes at substantially the same rate as the non-planar conductive surface layer.

Metallic conducting material layer is not shown or suggested by Mayer

Applicants submit that amended independent claim 1 is not taught or suggested by the references, that the dependent claims are also allowable over the references. In particular, amended independent claim 1 recites applying a metallic conducting material layer having substantially a same conductivity characteristic as the non-planar conductive surface layer to form a planarized multi-layer structure. Support for the amendment to claim 1 is stated in paragraph 39, lines 3-6 of

the Specification. Contrary to claim 1, Mayer states the characteristic of the diffusion barrier film as follows:

Preferably, it has a diffusion coefficient for ions of the material to be removed that is lower than the diffusion coefficient for such ions in the primary electropolishing bath electrolyte. ... In some embodiments, the diffusion barrier film is a viscous liquid that is soluble in an electropolishing bath electrolyte. In one specific embodiment, the diffusion barrier film is phosphoric acid having a concentration of at least about 25% by weight (more preferably between about 40 and 85% by weight). Such diffusion barrier film may include one or more of water, propylene carbonate, and ethylene carbonate. ... Generally, the diffusion barrier film may be soluble or insoluble in the electropolishing bath electrolyte. It may be conductive or non-conductive to ions generated from the substrate during the electropolishing. In a preferred embodiment, the diffusion barrier film is a polymeric film such as nylon, polyvinylidene difluoride (PVDF), polyacrylonitrile (PAN), polymethylacrylonitrile (PMAN), polyvinylchloride (PVC), and ethylene propylene diene monomer (EPDM). (Emphasis supplied) Col. 3, lines 26-55.

Mayer discloses in the preferred embodiment many possible diffusion barrier films as being a polymeric film, which has characteristics of being non-conducting. Accordingly, Mayer does not show or teach applying a metallic conducting material layer having substantially a same conductivity characteristic as the non-planar conductive surface layer to form a planarized multi-layer structure.

Polishing at substantially same rate is not shown or suggested by Mayer in view of Shue

The Office Action further rejects claim 1 “because the combined Mayer and Shue has the conducting material that is similar to the material of the conductive surface layer, the electropolishing of both layers at substantially the same rate would have been expected.”

The Examiner concedes that Mayer does not teach that the conductive material and the conductive surface layer may be electropolished at substantially the same rate but asserts that Shue teaches that a layer of copper alloy may be deposited over the damascene wiring trench using any of several methods and then electropolished in order to prevent any dishing effects (col. 3, lines 26-38). Hence, it would have been obvious to one with ordinary skill in the art to modify Mayer by using a layer of copper alloy as taught by Shue in order to prevent any dishing effects.

Applicants respectively traverse the assertion of the Examiner. Shue discloses deposition of chrome-copper alloy with a relative hardness that prevents dishing effects as follows:

Referring now to FIG. 2, in a key feature of the present invention, a layer of chrome-copper alloy 21 is deposited over the surface of the dielectric layer 1 as well as the top surface of the damascene wiring trench 3 to a

thickness between about 500 and 3,000 Angstroms. Deposition of the chrome-copper may be achieved by any of several methods, including chemical vapor deposition, physical vapor deposition, or electroplating. The chrome-copper alloy contains between about 1 and 15 atomic % chromium. Layer 21 is then planarized, using either chemical mechanical polishing or electropolishing, giving the structure the appearance illustrated in FIG. 3. The relative hardness of the chrome-copper alloy prevents the reappearance of any dishing effects. (Emphasis supplied) Col. 3, lines 26-38.

The above passage of Shue provides that the relative hardness of the deposited chrome-copper alloy prevents dishing effects that can occur using either chemical mechanical polishing or electropolishing. Shue does not provide the guidance as suggested by the Examiner that the electropolishing of both layers is at substantially the same rate. On the contrary, both Shue and Mayer disclose filling the damascene wiring trench with a material that impedes the polishing rate over the damascene wiring trench. Mayer applies a diffusion layer or thin polymer film to fill the damascene wiring trench on the wafer surface so electropolishing is performed through the thin film thereby slowing polishing of the damascene wiring trench. (See Mayer col. 7, lines 58-63). Shue deposits chrome-copper alloy over the damascene wiring trench, which has a relative hardness that prevents dishing. Accordingly, the Mayer reference in combination with Shue do not suggest that the deposited metallic conducting material layer be electropolished at substantially the same rate as the non-planar conductive surface layer. Skill in the art does not provide the differences between the references and the claimed invention. Applicants submit that independent claim 1 is patentable over the references.

Claims 2 and 3 further recite “annealing the conducting material layer so that at least one solute within the conducting material layer diffuse with the conductive surface layer.” The combination of Mayer and Shue do not teach or suggest the claimed invention requiring a “annealing the conducting material layer so that at least one solute within the conducting material layer diffuse with the conductive surface layer.”

Claims 4, 5 and 6 require removing the material to expose a barrier layer. Applicants submit that the references do not teach or suggest the claimed invention in combination with the limitations set forth in claims from which they depend.

Claims 7, 8 and 9 require removing the material to expose a dielectric layer. Applicants submit that the references do not teach or suggest the claimed invention in combination with the limitations set forth in claims from which they depend.

Claims 10-14 are directed to various aspects of the conducting material. Applicants submit that the references do not teach or suggest the claimed invention in combination with the limitations set forth in claims from which they depend.

Claims 15 and 16 are directed to the electropolishing step. Applicants submit that the references do not teach or suggest the claimed invention in combination with the limitations set forth in claims from which they depend.

Applicants submit that skill in the art does not provide the differences between the references and the claimed invention. An engineer skilled in the art would not develop the claimed invention with these references and skill in the art.

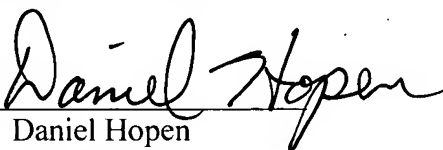
For these reasons, Applicants submit that the claimed invention is not taught or suggested by the references alone or in combination. It is submitted that the pending claims are allowable over the references and that the Examiner withdraw the §103 rejections. Applicants therefore request that the Examiner enter the amendment as it places the application in condition for allowance or presents the rejected claims in better form for consideration on appeal.

Conclusion

Applicants have amended the claims to further present the rejected claims in better form for consideration on appeal and to place the application in condition for allowance. For these reasons, Applicants respectfully request that the Examiner enter the amendment and reconsider and withdraw the rejections of the claims.

If any matters can be resolved by telephone, Applicants request that the Patent and Trademark Office call the Applicants at the telephone number listed below.

Respectfully submitted,

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